III. THE KIVA-3V VALVE MODEL

KIVA-3V can model any number of valves in the cylinder head. Each valve can have its own size and profi

EXHAUST

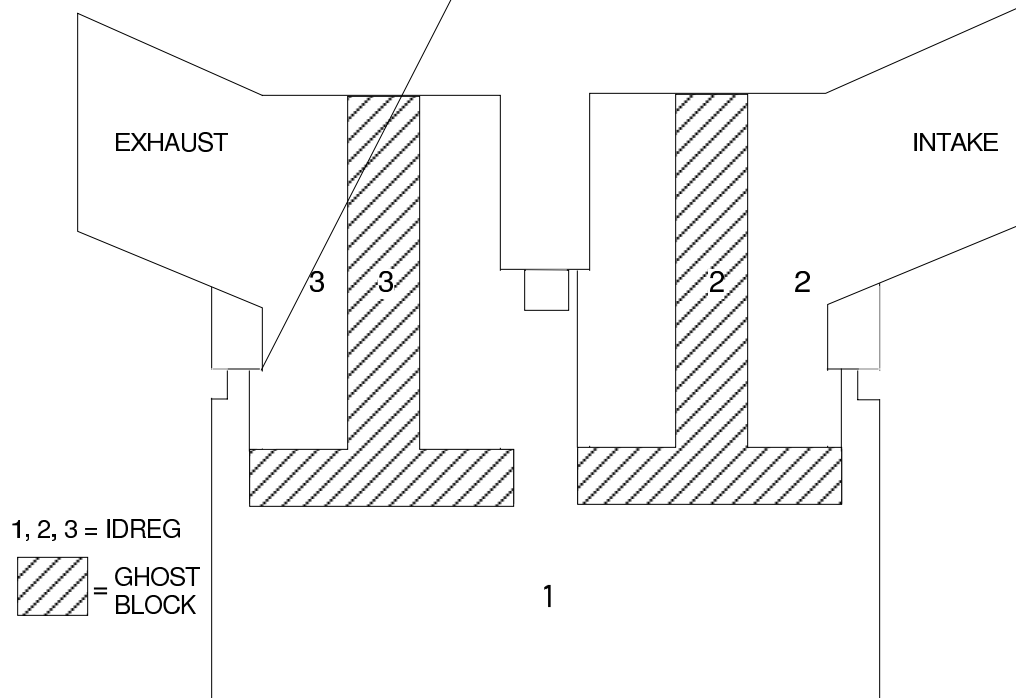INTAKE

3 3 2 2

1, 2, 3 = IDREG

= GHOST BLOCK

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Fig. 1. The three physical regions in a KIVA-3V grid for a typical valved IC engine.

currently above or below them. Cells in a valve recess or pocket always have IDREG = 1.

A new vertex flag array, IDFACE, must also be supplied by the grid generator as part of the ITAPE17 data file. *The addition of IDFACE is the only change to the ITAPE17 file.* In the original KIVA-3, there were only two possible moving surfaces: the piston and the optional upper piston. The program was able to use z-coordinates and vertex and flag information to identify moving surfaces, without requiring additional input data. The implementation of valves and their associated multiple moving surfaces requires additional information to identify *which* moving surface a vertex or cell face is identified with. By the new definition, a lower piston is always moving surface 0, and all vertices on the piston face have a flag IDFACE = 0. Vertices on the upper piston face in an opposed-piston geometry have vertex flags IDFACE = 1.

Although both the lower and upper surface of a valve move with the same velocity, each surface is identified separately because each moving surface is treated as a separate entity by the valve snappers. Because an upper piston is not an option in a valved geometry, the value IDFACE = 1 is available. The vertices of bottom surfaces of valves (i.e., the valve face) always have *odd* values for IDFACE (1, 3, ...), and the top valve surfaces and stems always have *even* values for IDFACE (2, 4, ...). By this definition, any moving surface, be it piston or valve, that has fluid above it has an even IDFACE. Conversely, if fluid lies below

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the face, the IDFACE is odd. All the remaining vertices in the grid, which are not associated with any moving surface, are assigned IDFACE = –1.

B.   Valve Data in File ITAPE5

* NVALVES is the number of valves,

   and for *each* valve:

* VLIFTMIN, the minimum lift in cm, below which the valve is closed;
* SKIRTTH, the thickness of the vertical edge of the valve, in cm ;
* TMOVE, the valve temperature in Kelvins. (Because a temperature for each valve can now be specified, the previous TVALVE line in earlier ITAPE5 files has been deleted);
* VTILTXZ, the valve cant angle from cylinder axis, in degrees: + , -, or 0.0;
* NLIFT, the number of lift entries for the valve on file ITAPE18.

C.   Valve Lift Data: File ITAPE18

Input data file ITAPE18 (free format) is a table of crank angles (integers) and corresponding valve lifts in cm (real numbers). The table must provide the lift information for one complete engine cycle: 0° to 720° for a 4-stroke engine, or 0° to 360° for a 2-stroke engine. KIVA-3V determines the length of an engine cycle from the new input quantity REVREP (revolutions between repetion), which should be specified as 2.0 for a 4-stroke engine, or 1.0 for a 2-stroke engine. All crank angles for which the lift is zero may be excluded from ITAPE18, which minimizes the length of the file. In addition, the crank angle increment from one line to the next is not required to be uniform throughout the file. The history for each valve appears in succession, with NLIFT lines per valve.

D.   Valve Movement

Each cycle, subroutine VALVE interpolates the lifts and velocities of the valves at the current crank angle from the data on ITAPE18. If the current crank angle lies outside the table range, the subroutine will use the appropriate equivalent crank angle inside the table range, permitting multiple engine cycles to be calculated. In physical space, the vertices that lie on a valve surface move as a unit each cycle in subroutine REZONE, using the current valve velocity components (UMOVE, WMOVE). Vertices on the valve stem are assigned the valve velocity, which allows the proper wall stress to be calculated and spray particles on the stem to be moved. To preserve the original zoning in the port, these vertices are never actually moved in subroutine REZONE.

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